• COLORADO RIVER •

AQUEDUCT NEWS

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Vol. VI. MARCH 25, 1939 No. 3

EARTH MOVING EQUIPMENT AT THE PALOS VERDES RESERVOIR

Note the size of the huge carryall as compared with the man standing by it in the center foreground.

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AQUEDUCT NEWS
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

306 West Third St.
Los Angeles, California

Published monthly in the interest of Field and Office Workers on the Colorado River Aqueduct, and for the information of all other citizens of the Metropolitan **Water District**

Vol. VI March 25, 1939 No. 3

Filtration and Softening Plant To Be Built

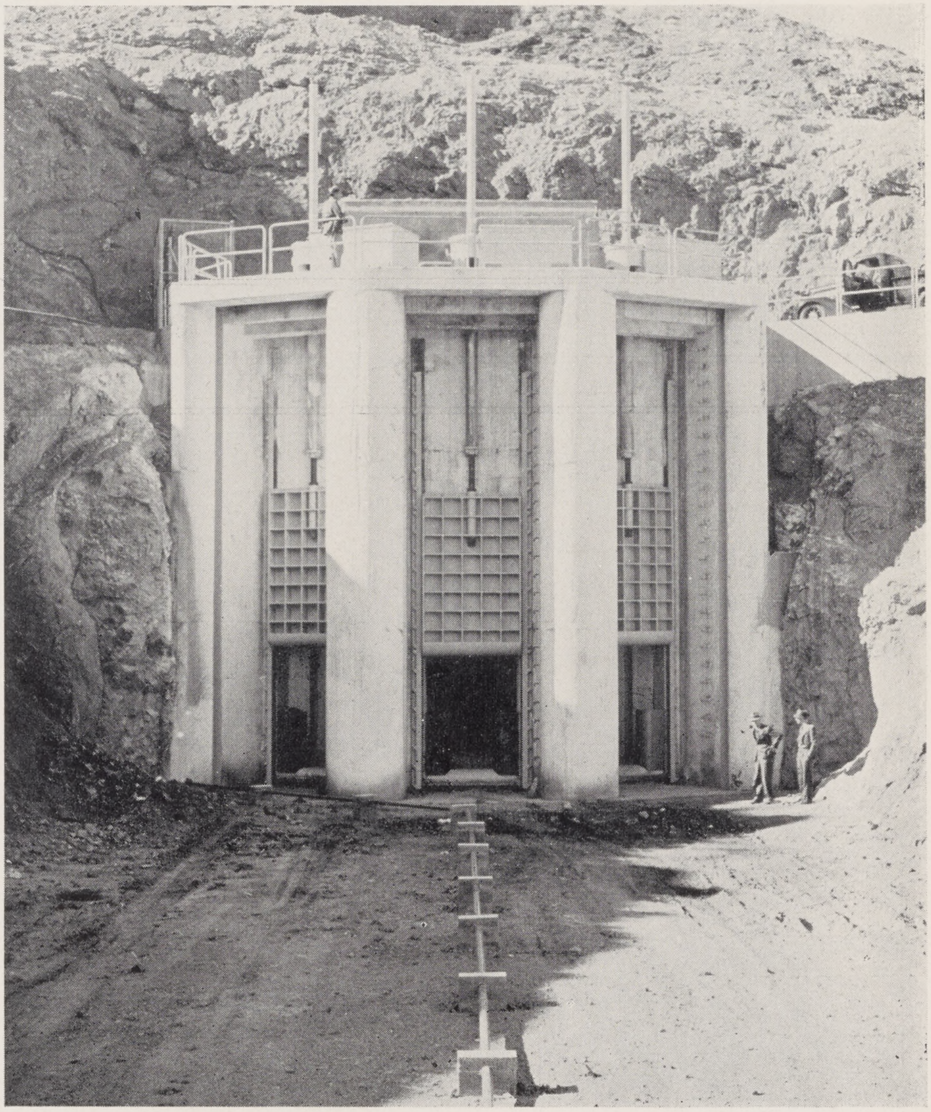
Colorado River Aqueduct water which will be used for domestic purposes in the cities of The Metropolitan Water District will be filtered and softened to a degree which will make it water of a better quality than that now being generally used by District residents, according to a policy adopted by the Board of Directors of the Water District.

In order to carry out this policy, the Board of Directors on March 10 authorized General Manager Weymouth to proceed with the construction of a water filtration and softening plant to be located on the upper feeder of the distribution system.

For the past few months, acting under authority granted by the Board of Directors in the latter part of 1938, General Manager Weymouth has been directing the preparation of plans and specifications for such a plant. Present plans contemplate the initial construction of a plant having a capacity of 100 million gallons per day to be located on the upper feeder in the vicinity of San Dimas (see story page 11).

The location of the plant will make it possible to supply filtered and softened water for domestic uses to all of the member cities as served by the present development of the distribution system, and will also provide such service for future "middle feeder" developments of the system.

It is not planned to use the softened water for agricultural use within the District, and the location of the plant will make it possible to supply raw Colorado River water to highly developed citrus producing areas which may be annexed to the Metropolitan Water District in the future.



COPPER BASIN RESERVOIR OUTLET STRUCTURE

Located at the east portal of the Whipple Mountain Tunnel, the gates in this structure are now submerged beneath the surface of the water in the Copper Basin Reservoir.

— DIRECTORY —

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Chief Elec. Engineer....................J. M. Gaylord
Asst. to Gen. Mgr., Don J. Kinsey
Secy. to Gen. Mgr....................Elisabeth von Hagen

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Distribution................R. B. Diemer
Transmission......Robert N. Allen
Maintenance................W. J. Neale
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SUPERINTENDENTS OF CONSTRUCTION PUMPING PLANTS

Intake and Gene........T. T. Walsh
Iron Mt.......................B. H. Martin
Eagle Mt. and Hayfield....................G. E. Archibald

SUPERINTENDENTS

(Main Aqueduct Tunnels)

San Jacinto Tunnel, District Force Acct., B. C. Leadbetter, Gen. Supt.; C. E. Sides, Tunnel Supt.; Edwin Noon, Supt.; F. A. Backman, Gen. Foreman.

(Distribution Pipe Line)

Schedules 21SC, 22SC, 23SC, J. F. Shea Co., Gilbert J. Shea, Gen. Mgr.; H. F. Rennebohm, Supt.

Schedules 24SC, 25SC, Emsco Derrick & Equipment Co.

Schedules 26SC, 27SC, 28C, Western Pipe and Steel Co.

Palos Verdes Reservoir, W. E. Hall Co.; Magnus Hjalmarson, Const. Supt.; L. W. Irwin, Const. Eng.

San Gabriel Canyon Spillway: J. F. Shea Co., H. F. Rennebohm, Supt.

CONSTRUCTION SCENES ON SCHEDULE 24SC, PALOS VERDES FEEDER

Top: Equipment used in spinning steel pipe for application of cement mortar lining; Center, left: Clock-controlled water spray for curing mortar lining; Right: Trenching machine; Bottom, left and center: Placing pipe in trench; Right: Field welding.

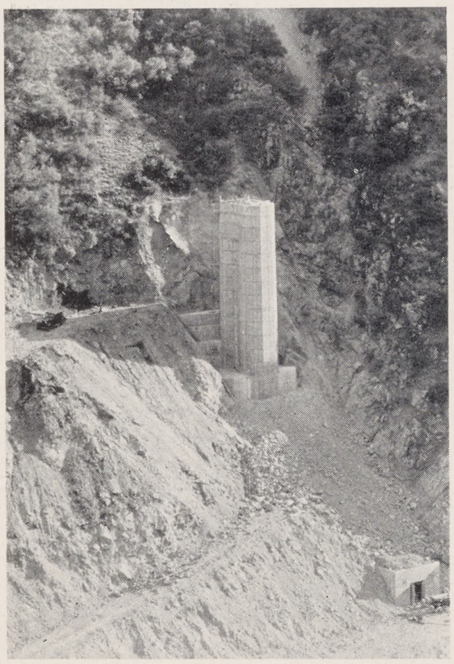
Iron Mt. Pump Tests To Start About April 3

Preliminary operation of the Iron Mountain pumping plant, the third of the five aqueduct pumping plants, will begin about April 3, according to a schedule laid out under the direction of James M. Gaylord, Chief Electrical Engineer of the District.

Sufficient water to fill the forebay at Iron Mountain plant, approximately 100 acre feet, will be released from Copper Basin reservoir during the last week in March and will flow by gravity for approximately 58 miles, through the Whipple Mountain tunnel and various conduits, siphons and canals,

The Iron Mountain plant will lift water approximately 143 feet and discharge it into the Iron Mountain tunnel. Both the pumps and the motors (4,300 horse power each) at this plant were built by the Allis-Chalmers Manufacturing Company. The pumping plant buildings and appurtenant works were constructed by the contracting firm of Wood and Bevanda.

It is planned to start preliminary tests at the Eagle Mt. plant about the middle of April, after which both Iron Mt. and Eagle Mt. plants, in conjunction with Intake and Gene will operate at full capacity and start filling the Hayfield Reservoir.



Gate tower at west portal of Monrovia Tunnel No. 1 in San Gabriel Canyon.

MONTHLY REPORT REVIEWS ACTIVITIES ALONG THE AQUEDUCT LINE

(EDITOR'S NOTE: The following is a brief summary of some of the activities of the District as set forth in the monthly report of General Manager F. E. Weymouth, filed with the Board of Directors in March, covering work done in February.)

Miscellaneous Activities Division

During the month of February, 179 labor employment applicants were cleared for work on the aqueduct, of which 3 were made available for force account work and 176 were made available to aqueduct contractors. Identification certificates were issued to 74 applicants, making a total of 26,234 such certificates issued to February 28, inclusive. The net turnover for all positions for January was 1.98 per cent.

Main Aqueduct

Salvage Division—Sales at the Banning salvage yard during the month amounted to $30,615, and transfers to District features or divisions amounted to $17,531.06. Total sales to date amount to $320,758.47, and total transfers to District features or divisions amount to $145,181.95.

Maintenace—Check dams and bulkheads were removed from Hayfield, Cottonwood, Mecca Pass, and the East Coachella tunnels, making 55 miles of main aqueduct tunnels cleaned to date. Check dams, debris, and bulkheads were removed from the conduit sections and siphons on Schedules 13, 14, 15, and 16, making a total of 106 miles of open canal, conduit, and siphon sections cleaned to date and ready for operation.

Construction—The placing of the plate steel incasements and waterproofing on the lower portions of the structural steel arch of the Topock highway bridge were completed February 15. At the end of the month 1500 acres had been cleared in the Hayfield reservoir, being 44 per cent of the area.

San Jacinto Tunnel—The placing of the invert concrete in this tunnel was completed on February 4. Both the East Portal and the West Portal crews made good progress in lining the arch. At the end of February 8.21 miles of arch and all of the 13.04 miles of invert had been placed.

Civil Engineering Division

Specifications—Five sets of specifications were being prepared during the month, including No. 302 for mechanical equipment for the water softening plant (see story on page 11).

Design—The major activity of the Design Division continued to be the preparation of plans for the water softening and filtration plant, including designs and specification drawings for valves, flow controllers, meters, pumps, and lime reclamation furnaces. Major architectural and structural features of the head house, administration, and zeolite buildings were decided on and detailing of these buildings was in progress.

Materials—Owing to increased activity in the lining of the San Jacinto tunnel, 49,000 barrels of cement were shipped during the month, and 37,500 barrels were tested and released for shipment.

Hydrography—Boulder Canyon reservoir storage has been reduced to 21,300,000 acre feet, as compared with a maximum on August 1, 1938, of 23,140,000 acre feet. This emptying of the flood control reserve has been accomplished by means of discharge averaging 25,000 second feet, and as high as 32,000 second feet during the past five weeks, in anticipation of an exceptionally high flood run-off as forecasted by extensive snow surveys in the upper Colorado River basin. It is now expected that the inflow will be sufficient to practically fill the Boulder Canyon reservoir by July 1, giving the first opportunity to operate and test the dam's spillway gates.

Distribution Division

Construction of the Distribution System headworks was completed February 7, and the contract for construction of San Gabriel, Monrovia, and Eagle Rock Canyon crossings was completed February 8.

Electrical Engineering Division

All three pumps in the Gene plant were placed in operation January 31, and began filling the Copper Basin reservoir which was filled to the spillway level on February 27. See story first column, this page.

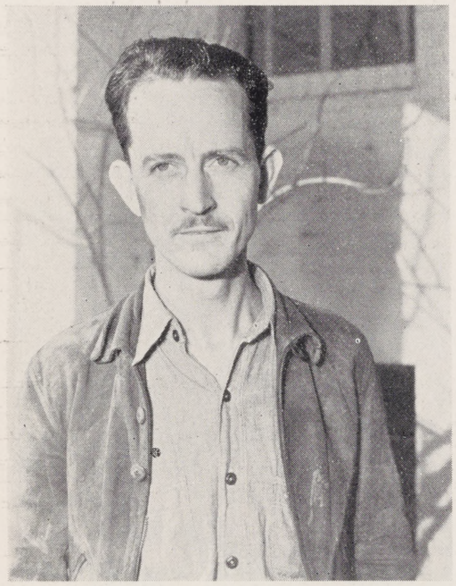
Purchasing Division

Purchase orders totaled 761 and amounted to $60,000.00. Carload forwardings totaled 456.

Accounting and Costkeeping

The total cost of the work accomplished to February 28, 1939, was $175,490,809.

NEWS FROM FIELD AND OFFICE



This is Don R. S. DeWitt, who has practically lived underground since he started work for the District in January 1933. During the past six years he has been employed almost entirely on tunnel construction work. He was chief inspector on the lining of the Valverde Tunnel in 1935-1936, and since June 1937 he has been chief inspector at the Potrero Shaft of the San Jacinto tunnel. Vital statistics records indicate that, although he was born in Lincoln, Nebraska (January 25, 1904), he grew up in Long Beach, Calif. V.s.r. also states that Don is married and has one daughter.

Mr. J. B. Bond, who was well known to all those who worked on the main aqueduct, sailed from New York on March 3 for Venezuela where he will be engaged in an engineering investigation of a large irrigation project in that country. Mr. Bond was first employed by the District in 1929 and was in charge of investigations, surveys, and estimates for the main aqueduct, and during the heavy construction period he was division engineer of divisions 5 and 6.

* * *

A note in the mail announces the marriage on March 4, in Fresno, of Shirley Marie Meeker and Edwin Clark Osborn. "Ed" Osborn is an ex-aqueducker who was last employed in the personnel office and is now a member of the M.W.D. alumni chapter at the Lockheed Aircraft Company in Burbank.

SAFETY AWARD

The lost-time accident frequency record for the San Jacinto tunnel for the month of February was 74, the same as for the month of January. East Portal won the safety flag for the best record in February.

Aqueduct Temperatures

February 15 to March 15, 1939

	Max.	Min.
Div. 1	77°	37°
Div. 2	75°	39°
Div. 3	74°	37°
Div. 5	73°	26°

An unnamed, but nevertheless greatly appreciated correspondent from Beaumont sends in word that "proud pappa, W. E. Houser of Potrero, passed out cigars on February 26 to announce the arrival of a son and heir, Walter Richard, who weighed in at 9 pounds, 8 ounces." The pappa is an old timer on the job, who, according to the correspondent, is still a bit wobbly on his feet although mother and son are doing fine.

* * *

Another old timer who has just graduated to the alumni section is Fred Haines, formerly of the Distribution Division, who resigned from the District on March 20 to accept a position as Assistant Hydraulic Engineer with the Division of Water Resources of the State of California. Fred was one of the real "ancients," and had been on the job since September 28, 1925, his principal work having been hydraulic design and the preparation of estimates.

* * *

Claude H. Bowman, who was hired by the District as a plumber foreman in May, 1933, and who for the last year has been employed on the San Jacinto tunnel job, started to work for the Los Angeles County Board of Education on March 1. Bowman received the highest mark in the examination given for his type of work and was No. 1 on the civil service list.

* * *

The following men have recently been transferred from the Intake and Gene plants to the Iron Mountain pumping plant: Dan P. Gabele, Gregory B. Bynan, William T. Croden,

News Index for 1938

For the benefit of those who are keeping complete files of the AQUEDUCT NEWS, an index of all numbers of the 1938 issues of the NEWS (Vol. V) has been prepared and is now available for distribution. Copies of this index may be obtained from the information desk or by writing to the District at its Los Angeles headquarters.

In case some of you thought it may have been nippy in the early mornings during the past winter, console yourselves with the thought that it might have been much, much worse. The gang at the Palos Verdes reservoir received a letter recently from R. B. "Dick" Ward, formerly Resident Engineer on the construction at Cajalco Reservoir. "Dick" is now engaged in the construction of the Green Mountain Dam in northern Colorado. The letter was dated February 27, 1939, and in it "Dick" stated that on the day before the temperature had been 45 degress *below* zero. Seems like a lot of explorers have been wasting a lot of time going to the poles in search of cold weather.

* * *

Ileah McCleary, who had been an aqueducker since January, 1933, and who during the last six years has been employed in the Controller's office, left the District early in March. A rumor, which is not denied by either of the principals, states that Ileah will become Mrs. Charles J. Brandt sometime during the month of June. The expectant husband, who has been on the aqueduct job for a long, long time, may be seen most any noon practicing "aisle" marching in the hallways in an effort to get his legs accustomed to the idea so that his knees won't clank together too loudly when the final event is called.

Harry W. "Ras" Rasmussen (above) is Bill Fox's only professional rival on the job. While Bill explores the inside of aqueduct tunnels with his camera, "Ras" is exploring the interiors of various and sundry aqueduckers with his X-Ray camera. His job is X-Ray technician and surgical nurse in the M.W.D. Banning Hospital. Some of these days "Ras" may make the front cover of the NEWS with one of his objects de art.

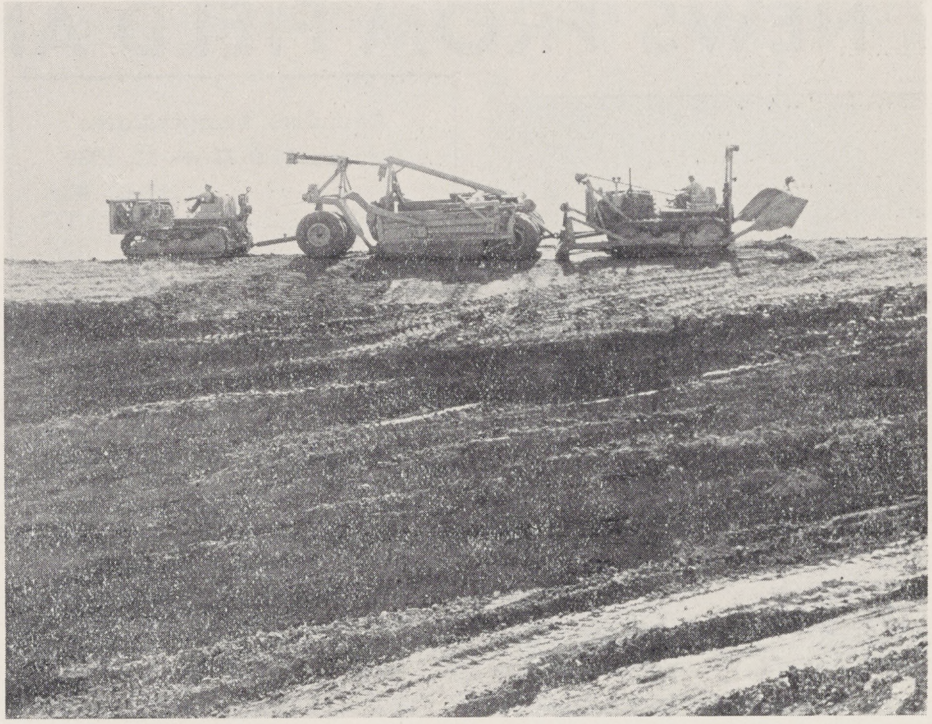
DISTRIBUTION

(*Continued from Page* 4.)

coal tar enamel on the inside and a ¾-inch outside coating of gunite reinforced with steel wire mesh. Where very corrosive soil conditions existed, an outside coating of coal tar enamel was also used underneath the gunite. For best results in obtaining a bond between the enamel and the steel, it was found necessary to preheat the pipe to a temperature of about 190° for the enameling operation. All enameled surfaces, both inside and outside, were carefully inspected for imperfections by means of an electrical detector.

After the enameling had been completed in the Los Angeles plants, the fabricated pipe sections were shipped by rail to a centrally located field plant, near the trench, where the gunite coating was applied and cured for seven days. In curing the gunite a water spray was used for a period of 4 to 8 hours, after which two coats of coal tar cutback were sprayed on, and covered with whitewash for temperature control. An exterior coating of whitewash for temperature control also was used when the enameled pipe was shipped from Los Angeles to the field.

A specially designed tractor gantry handled the pipe in the field yard. This gantry was very mobile and did not require the use of tracks. The gunited pipe sections weighing from 18 to 30 tons were transported from the field yard to the trench side on trucks constructed especially for this purpose, and were unloaded from the trucks and placed in the trench by a heavy duty crawler type crane which traveled along the roadway beside the trench.



Push and pull combination at work on the Palos Verdes reservoir. Loading of this big, 24 cubic yard, scraper carryall is speeded with the help of the "pusher" tractor.

All field joints were lap welded with portable arc welding machines. Each welded joint was tested by forcing a soap solution under 100 pounds pressure into the space between the inside and outside welds. After this test, the enamel and gunite coatings were completed at the joints and the pipe was backfilled by puddling.

Good progress was made on the installation of the steel pipe. Average daily advance using about twenty welding machines was six pipe sections or 200 lineal feet.

The precast concrete pipe portions of the upper feeder were constructed by three separate contractors under a total of five contracts, varying in length from 4.5 to 11 miles. Nine and a half miles of line with hydraulic heads under 75 feet were built with bell and spigot mortar type joints, while 26 miles were built with steel and lead lock joints. All precast concrete pipe was cast in sections 12 feet long. Heads range from 25 to 290 feet.

Reinforcement was computed for a combination of external and internal loading. For heads less than 80 feet, a combination of circular and elliptical bar

Spreading and rolling earth on the Palos Verdes reservoir job. The carryalls, tractors, and sheeps-foot rollers being used on this work are among the largest that are manufactured.

cages was used. For greater heads, a thin steel cylinder was added to the assembly for water tightness and as a part of the reinforcement for internal pressures. Lock joints, where used, were welded to bar cages or steel cylinder and bar cages as required.

A complete plant for manufacturing and curing the precast concrete pipe was established by each of the three contractors at a convenient point near the pipe line. Procedures varied somewhat as to detail at the various plants, but were similar in all essential respects. Daily output at the plants varied from 12 to 16 pipe sections, and was governed by the number of forms provided for the work.

Bar reinforcement was wound into cages on an electrically driven drum and welded to the longitudinal steel, and lock joints where used, to form a complete unit. Concrete for the pipe was mixed by customary methods at a central mixer for the plant, and was placed in the forms from a hopper on a movable placing gantry. Stationary electric vibrators attached to the forms moderately vibrated the concrete while it was being placed in the forms. After the concrete was placed it was worked by a novel device, consisting of an air actuated rotary steel rod, about three feet longer than the depth of form, revolved at about 500 r.p.m while it was pushed down into the concrete along the face of the form. Excellent dense concrete with smooth surfaces free from air and water pockets was obtained by this method.

Forms were stripped after about 12 hours and the pipe was tipped off the base ring during the third day. The outer surfaces of the pipe were kept wet for several hours after stripping and then sprayed while wet with two coats of coal tar cutback, which were covered with whitewash. Both ends of the pipe were closed with portable bulkheads and the inside of the pipe was cured for about two weeks with a water spray operated automatically by clock control.

Due to the great weight of the pipe sections, ranging from 26 to 43 tons, depending upon diameter, special equipment was developed both for transporting the pipe from the yard to the trench side, and for installing the pipe in the trench. All of the trucks used for transportation were of the same general design, but the three contractors used different types of machines for placing the pipe in the trench. This difference was due mainly to variable right-of-way conditions.

The placer used in the open country east of Ontario for the 11-feet 8-inch and 12-feet 8-inch diameter pipe in this area consisted of a steam-operated stiff-leg derrick mounted on a structural steel frame which traveled on a 48-foot gage track spanning the trench. The placer used through citrus groves and in city streets for the 11-feet 8-inch diameter pipe line between Ontario and San Dimas consisted of a truss-type gantry which spanned the trench and traveled on rails laid to a 38-foot gage. This machine was electrically operated. For laying the smaller-sized pipe used west of San Dimas, 10 feet 3 inches and 9 feet 8 inches diameter, a heavy crawler type crane was used. This crane traveled along the construction road at the side of the trench.

All of the precast concrete pipe was bedded in concrete cradle, the placing of which closely followed the laying of the pipe. In lock-joint lines the lead gasket in the joint was lightly calked before the cradle was placed. The line was then backfilled and allowed to settle before final calking. After final calking, the space in the inside of the joint was filled with gunite. Backfill was settled by a combination of puddling and flooding.

Normal laying progress on the precast concrete pipe varied from 12 to 16 sections, 144 to 192 lineal feet per day, depending upon the capacity of the manufacturing plant. In general this amount of pipe could be placed in the trench during an 8-hour shift. The maximum number of pipe sections placed in eight hours was 30, which occurred when surplus pipe was available at the plant.

After completion, all pipe lines were filled with water and tested for leakage under full operating heads. The specifications for the work provided that the leakage loss per inch of diameter per mile of line should not exceed 15 gallons per day for the steel pipe and 100 gallons per day for the precast concrete pipe. The actual losses which occurred during the test periods were in all cases substantially less than the maximum allowed and average 7 gallons and 32 gallons per inch of diameter per mile of line per day for the steel line and precast concrete lines, respectively.

West of Glendora, the upper feeder consists of a series of tunnel and siphons of various lengths. Except at three short canyon crossings where cast-in-place concrete construction is provided, the siphons consist of precast concrete pipe. The tunnels are lined with concrete and have a finished diameter of 10 feet. Due to difference in construction methods the tunnels are classified into two distinctive types, namely, tunnels in rock and tunnels in alluvium, based upon the type of ground through which they pass.

The tunnels in rock are situated along the southerly slope of the San Gabriel mountains from Glendora to the Santa Anita wash and through the San Rafael hills west of the Arroyo Seco. These include the Monrovia Nos. 1, 2, 3, and 4 tunnels which have lengths of 1.5, 0.2, 6.1, and 1.5 miles, respectively, and the San Rafael Nos. 1 and 2 tunnels with lengths of 0.8 and 1.1 miles, respectively.

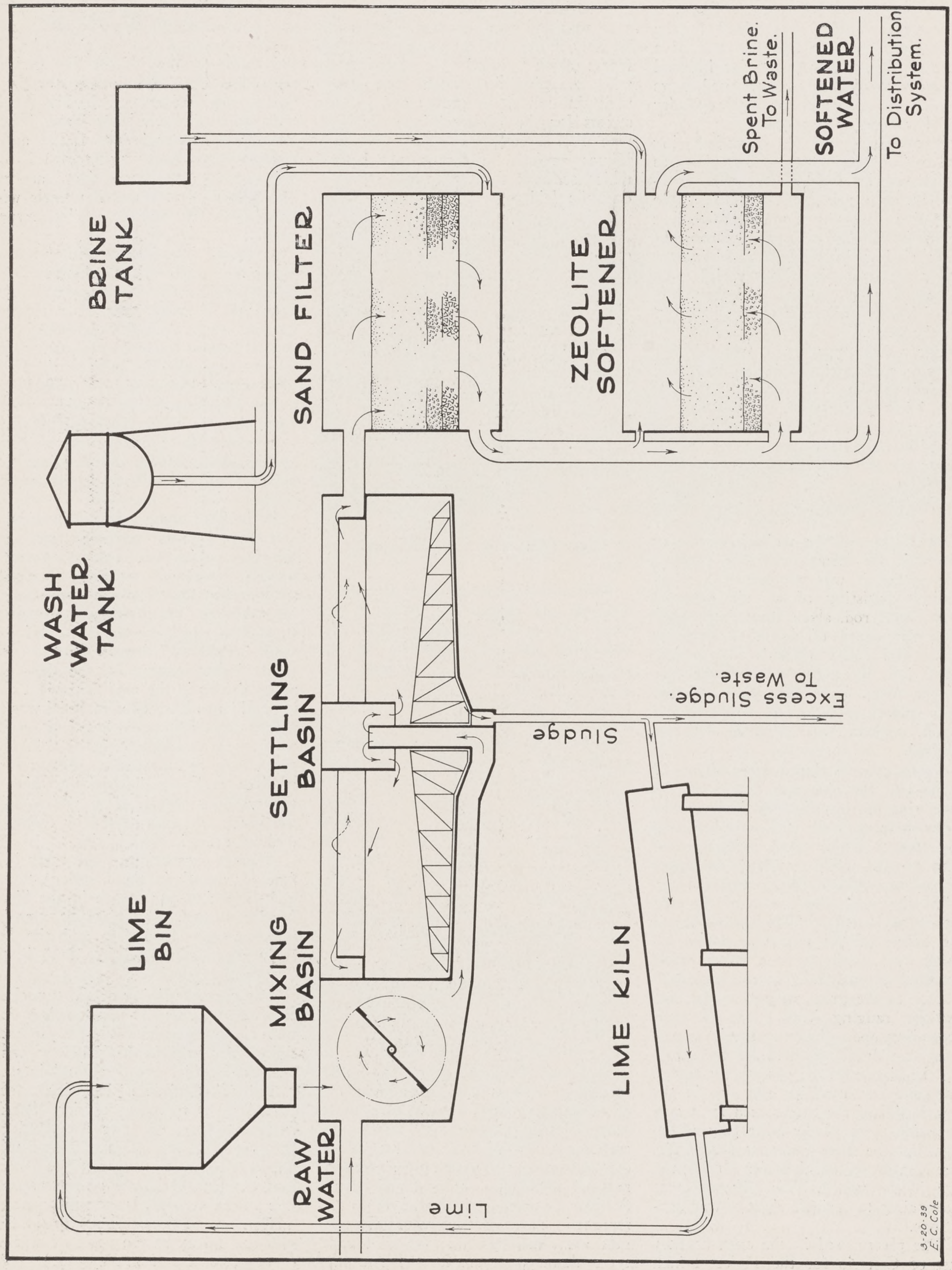
To avoid interference with improvements and traffic and the inconvenience to the public which accompanies the construction of large pipe lines through narrow streets in highly developed residential areas, portions of the upper feeder through the cities of Sierra Madre and Pasadena were constructed as tunnels through the alluvium underlying these cities at depths of 30 to 70 feet below the ground surface. These are the Sierra Madre and Pasadena tunnels, 1.3 and 3.4 miles in length, respectively.

In both of these tunnels the ground encountered was partially cemented alluvium which was readily excavated without blasting by means of pneumatic spaders and electrically-operated mucking machines. The ground was supported throughout using steel bents, fabricated from 5-inch "I" beams, backed with tight timber lagging on the sides and piling driven in the roof to prevent caving and runs. Excavated material was removed from the tunnel in 2 and 5 cubic yard dump cars operating on a 24-inch gage track and drawn by battery locomotives, and was dumped into bins at the working portal, from which point the muck was transported by trucks to disposal areas in the vicinity.

Average excavation progress was 1470 feet per month in the Pasadena tunnel and 1250 feet per month in the Sierra Madre tunnel. The greatest monthly progress was 2186 feet and the best daily progress was 93 feet, both in the Pasadena tunnel.

The concrete lining of the tunnels in alluvium was heavily reinforced, mainly with circumferential steel bars. Concrete lining was placed in the full circle, without longitudinal construction joints, by means of collapsible steel forms supported by a traveling carrier. Special forms and carriers were developed for this work. Concrete was placed with pneumatic guns in sections 60 to 80 feet long between bulkheads and one section was placed per day. In general, concrete materials were transported into the tunnels and mixed at the point of placing.

(*Continued on Page* 12.)



Diagramatic flow chart of water softening plant now being designed by M. W. D.

Lime-Zeolite Process to Soften Aqueduct Water For Domestic Use

Having authorized General Manager Weymouth to proceed with the construction of a plant at which aqueduct water distributed for domestic use within the cities of the District will be filtered and softened (see story page 2), the Board of Directors on March 10 awarded a contract to the Dorr Company for furnishing and erecting certain mechanical assemblies to be installed in the plant.

The equipment to be supplied will be furnished under Specifications No. 302, the contract price for furnishing the equipment being $79,993.35. This was the first set of specifications on which bids have been called for on the water softening plant.

During the last few months, the District's Design Division has been preparing plans and specifications for the plant under the direct supervision of Consulting Engineers Charles P. Hoover and James Montgomery, of Columbus, Ohio. These men are considered the foremost authorities in the United States on the subject of water softening.

Although some areas within the District are now using water which is harder than Colorado River water, the waters from local sources are variable and the average hardness of water used at the present time in the 13 District cities is somewhat lower than that of raw Colorado River water as it will be discharged from Cajalco Reresvoir.

None of the solids dissolved in unsoftened Colorado River water are harmful to plant or animal life, and the river water may be safely used for irrigation and drinking.

However, because of the modern demand throughout the United States for softened water, the District's Board of Directors has decided that Colorado River Aqueduct water used for domestic purposes should be filtered and softened to a point that will make it of better quality than water now generally being used by District residents.

Water used for domestic purposes is considered to be hard if a large quantity of soap is required to produce a lather, and is considered soft if it lathers freely. The hardness of water is due to compounds of calcium and magnesium which are dissolved in the water. The degree of hardness depends upon the amount of these compounds which are held in solution in the raw water.

The hardness of unsoftened Colorado River water is due primarily to three compounds which are held in solution. These are calcium bicarbonate (solution of limestone in water containing carbon dioxide); calcium sulphate (gypsum); and magnesium sulphate.

The softening plant now being designed for the aqueduct will be able to reduce the content of these compounds in the water to any degree, that is, to bring the water to any degree of softness that may be desirable.

The method of softening which has been adopted is known as the lime-zeolite process. It was recommended by Consulting Engineers Hoover and Montgomery as being the most economical for the District and as being able to produce the best results.

In general terms hard water is made soft by a process which changes calcium and magnesium compounds from a dissolved state to a solid form which can be removed from the water.

When lime is added to hard water, it will combine with the dissolved calicium bicarbonate already in the water and forms calcium carbonate or limestone. This limestone can then be settled out of the water, in basins provided for that purpose, and removed. This process reduces the "carbonate" hardness of the water.

However, in order to soften the water to a desirable degree, it is also necessary to reduce the "non-carbonate" or sulphate hardness. This latter consists of the calcium carbonate (gypsum) and magnesium sulphate content of the water. This calcium and magnesium is removed by filtering the water through a softening mineral known as zeolite.

Zeolite is a "base exchange" mineral, and has the appearance of fine sand. Hard water passed through a bed of this mineral exchanges all of its calcium and magnesium for a corresponding amount of sodium from the zeolite. The result is a zero hardness water.

Since zero hardness is not necessary, only a portion of the lime-softened water (the first step in the process) is passed through the zeolite softener, and it is then blended with the water which has been only lime-softened. The degree of softness of the final product is therefore regulated to any desired point by the amount of lime-softened water that is passed through the zeolite.

Although the zeolite loses its softening capacity as it becomes saturated with calcium and magnesium, it is not necessary to replace it with new material. The saturated zeolite can be regenerated by passing salt brine through it. By doing so the chemical action is reversed and the calcium and magnesium which have been absorbed from the softened water are taken out of the zeolite and replaced by sodium from the brine.

Another interesting feature of the process is that after the first lime is added to the water when the plant goes into initial service, it will not be necessary for the District to purchase additional lime for the operation of the plant.

For each pound of lime added to unsoftened water, approximately three and a half pounds of limestone will be precipitated and removed. A part of this limestone will be burned in a kiln which will reclaim sufficient lime to operate the plant. The lime thus reclaimed will be of a quality equal to or superior to that which can be purchased locally.

In addition to being softened to a degree equal to or better than water now in general use in the District cities, the aqueduct water used for domestic purposes will also be filtered, as a part of the softening process, and will be delivered clear and sparkling into the distribution system.

With the exception of Beverly Hills, no District city now supplies its consumers with filtered water. Filtration provides additional insurance against outbreaks of water borne diseases, and helps to control objectionable tastes, odors, and discoloration of the water.

When the District's plant is placed in operation it will be able to produce a quality of water for domestic consumption which will be superior to any water now being used in the cities of the District, or in any other part of Southern California.

On page 10 is shown a diagramatic sketch of the treatment plant to be built by the District. As indicated on this sketch, the raw, or unsoftened Colorado River water from Cajalco Reservoir, will first flow into a mixing basin in the plant where the necessary amount of lime will be added and mixed. The water (flow indicated by arrows) will then go into a settling basin where the calcium carbonate (limestone) will be precipitated and removed. Part of this limestone is then delivered to a kiln where lime is reclaimed for re-use in the softening plant.

After the limestone has been precipitated, the water will be passed through a gravity sand filter, and then a part of it will be passed through the zeolite softener. As explained above, the amount of water passed through the zeolite and then blended with the by-passed lime-softened water will regulate the degree of softness of the water turned into the distributing system.

DISTRIBUTION

(*Continued from Page* 9.)

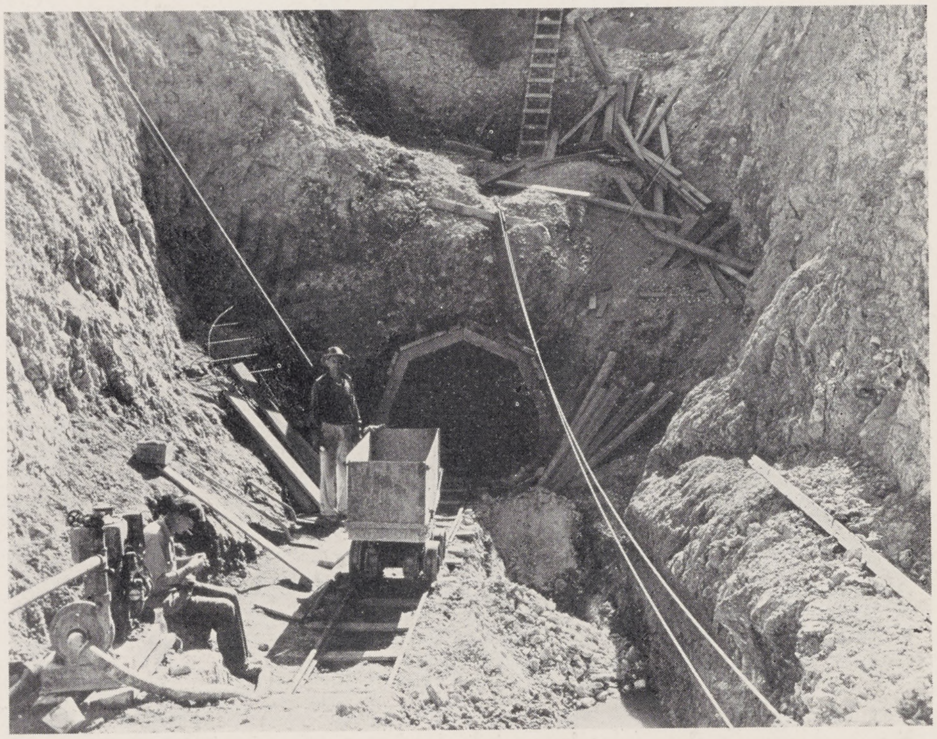
As it was not possible to remove lagging and spiling prior to concreting operations in the alluvium, due to danger of caving and runs, voids behind the lagging and spiling were filled with grout after the concrete lining had cured sufficiently.

Excavation in the rock tunnels involved the usual cycle of drilling, blasting, and mucking. In most cases only light support was required, consisting of steel ribs and timber lagging, although timber sets were placed in faulted or soft ground where greater support was required. Average excavation progress in all of the rock tunnels (working three 8-hour shifts) was about 30 feet per day or 800 feet per month for each heading; greatest monthly progress at one heading was 1210 feet in Monrovia No. 3 tunnel east of the adit.

Concrete was placed in the rock tunnels in a manner similar to that employed in the alluvial tunnels, excepting that in Monrovia No. 3 west of the adit, the placing of the invert concrete in advance of that in the sides and arch, with resulting longitudinal construction joints, was permitted in order to take care of the flow of water. Reinforcement steel was used in the concrete lining of the rock tunnels where the depth of cover was less than twice the pressure head, or where soft unstable ground was encountered.

In the westerly 2856 feet of Monrovia No. 4 tunnel, where the hydraulic head will range from 110 to 260 feet, a steel cylinder of 1-4 to 9-16 inch plates was used for reinforcement and water tightness. This cylinder has 13 inches of concrete behind it, while the inside is lined with a 2-inch coating gunite to protect the steel and improve flow conditions.

Appurtenant structures required for the satisfactory operation of the line have been installed at various places along the upper feeder. Blow-off facilities have been placed at low points for draining the line when necessary for inspection or maintenance; air and vacuum valves have been installed at high points; outlets have been provided at points convenient for supplying present member cities and probably future service areas; and two major overflow spillway structures have been constructed at drainage channels near points where the upper feeder is reduced in capacity. One of these spillways is situated at the Puddingstone flood control channel near San Dimas, while the other is at the westerly side of the Arroyo Seco. A third spillway is being constructed in San Gabriel Canyon near Morris reservoir.



Although it is neither the largest nor the smallest, this little tunnel leading into the Palos Verdes reservoir has the distinction of being the 42nd tunnel on the aqueduct system. It is 684 feet long and is excavated to a diameter of 6.5 feet.

The Palos Verdes cross feeder extending from the upper feeder near Eagle Rock to its regulating reservoir near San Pedro, is being constructed to serve a part of Los Angeles and member cities in the southwestern part of the metropolitan area. Appurtenant to this main cross feeder are laterals to Long Beach, Torrance and Compton. All of these lines are of welded steel pipe, coated on the inside with a ½-inch thickness of cement mortar, centrifugally applied by a spinning process, and coated on the outside with a ¾-inch thickness of gunite reinforced with wire mesh. A layer of coal tar enamel is used underneath the external gunite coating where corrosive soils are encountered.

Pipe lengths, sizes and plate thicknesses for the cross feeder and laterals are as follows:

	Length (Miles)	Dia.	Plate Thickness
Eagle Rock to Palos Verdes Reservoir......	25.4	51″	⅜″ - ½″
Eagle Rock to Palos Verdes Reservoir......	25.4	51″	⅜″ - ½″
Long Beach Lateral......	4.7	37″	⅜″
Torrance Lateral	1.2	31″	5-16″
Compton Lateral	1.3	22″	5-16″

The maximum normal operating head on the main cross feeder may vary between 340 and 450 feet.

These lines are located to a large extent in city streets. In congested areas excavation is accomplished with a ladder type trenching machine producing vertical trench walls which generally require sheeting. In open, undeveloped areas trenches are excavated by drag line. Work on these city lines is hampered by restricted working space, urban traffic, and the necessity of avoiding or moving previously installed utilities.

To prevent deflection of the pipe and cracking of the mortar lining as a result of the heavy load of unconsolidated backfill, temporary steel bulkheads are placed at each manhole, about 1,000 feet apart, and the pipe line maintained full of water under pressure during the backfilling operations, and thereafter until the backfill becomes consolidated.

The Palos Verdes reservoir site is in the Palos Verdes Hills west of San Pedro, at the end of the cross feeder. At this location, a small and irregular natural basin is being enlarged and improved in shape by excavation. The excavated material is used to close the outlet from the basin and to construct compacted embankments which will increase the capacity. The entire surface of the reservoir is to be lined with 2 inches of reinforced gunite. The reservoir will have a capacity of 1000 acre feet, a water surface of 28 acres, and a maximum water depth of 50 feet. Structures appurtenant to the reservoir are an inlet and outlet tunnel, an outlet tower, and a storm water drain around the site.